



# Commercial Freight Trucking Electrification

Dave Schaller  
May 2021



# No Membership Fees: Thanks to Sponsors



## 2021 Fiscal Support

Gold



Silver



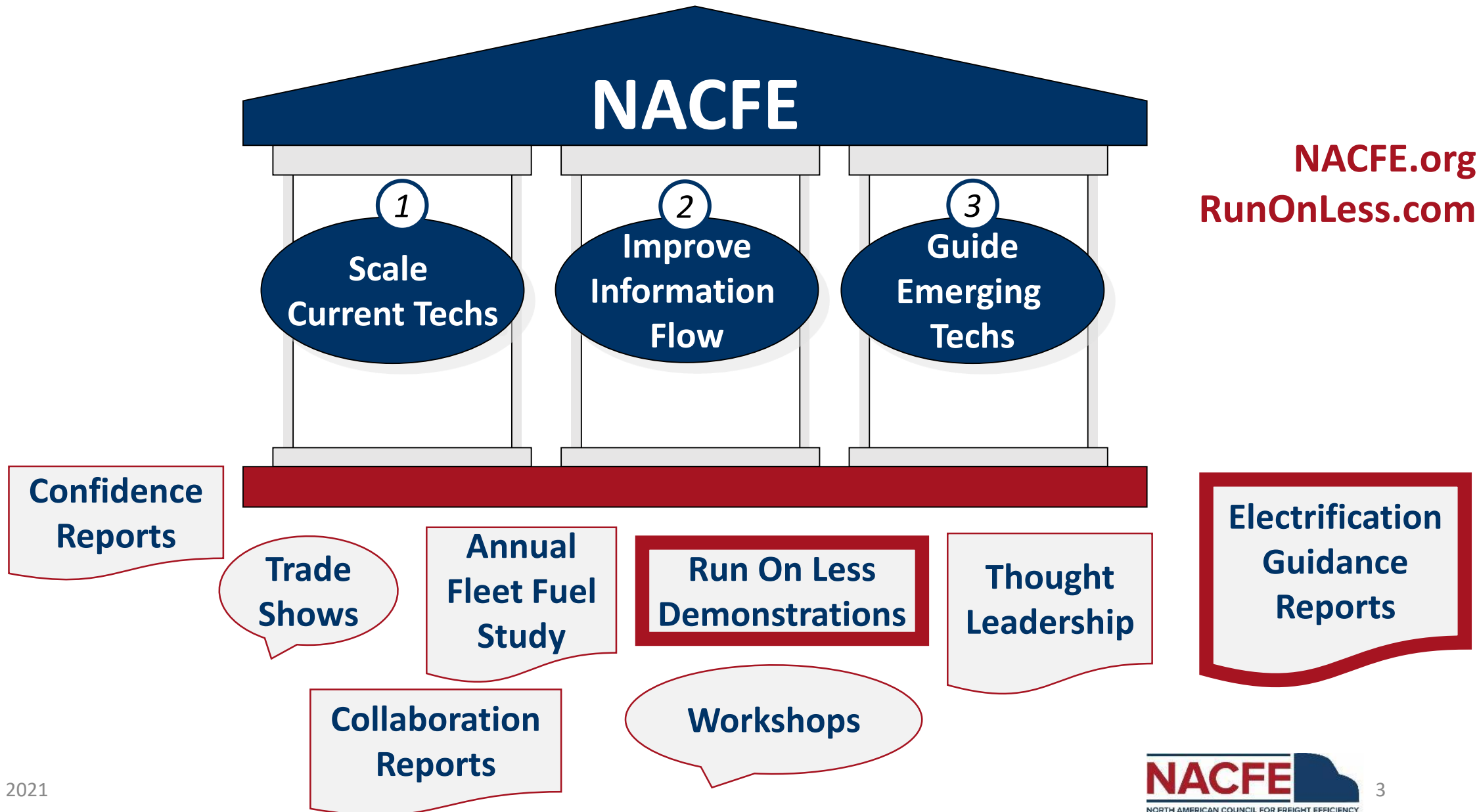
Bronze



Electric Trucks



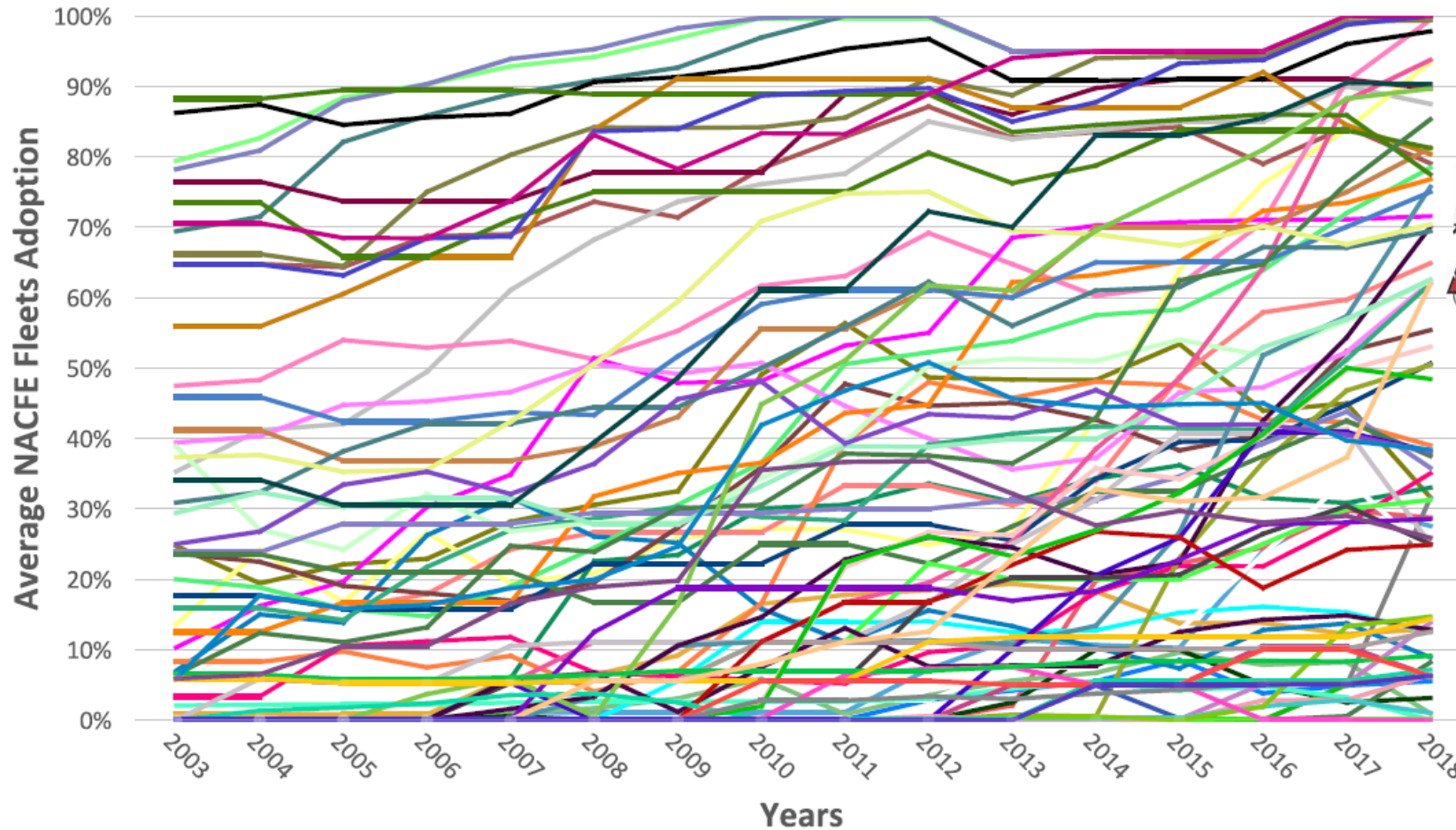
# Three Pillars of NACFE Work



# 2019 Annual Fleet Fuel Study



## All Technologies



April 2021



<https://nacfe.org/annual-fleet-fuel-studies/>



# Best of the Best

2017



Long Haul  
7 Fleets  
10.1 MPG

2019



Regional Haul  
10 Fleets  
8.3 MPG

2021



All BEVs  
13 Fleets  
New metrics!



# RoL-E Participants



- Interviewed 30+ potential pairs
- Required trucks to be in-service by June 1<sup>st</sup>
- Mix
  - Multiple classes and duty cycles
  - Multiple truck OEMs
  - Locations around NA
- Selection Criteria
  - Uptime, design maturity
  - Scale potential
  - Mix
  - Fleet / OEM commitment

# Timeline for Run on Less – Electric



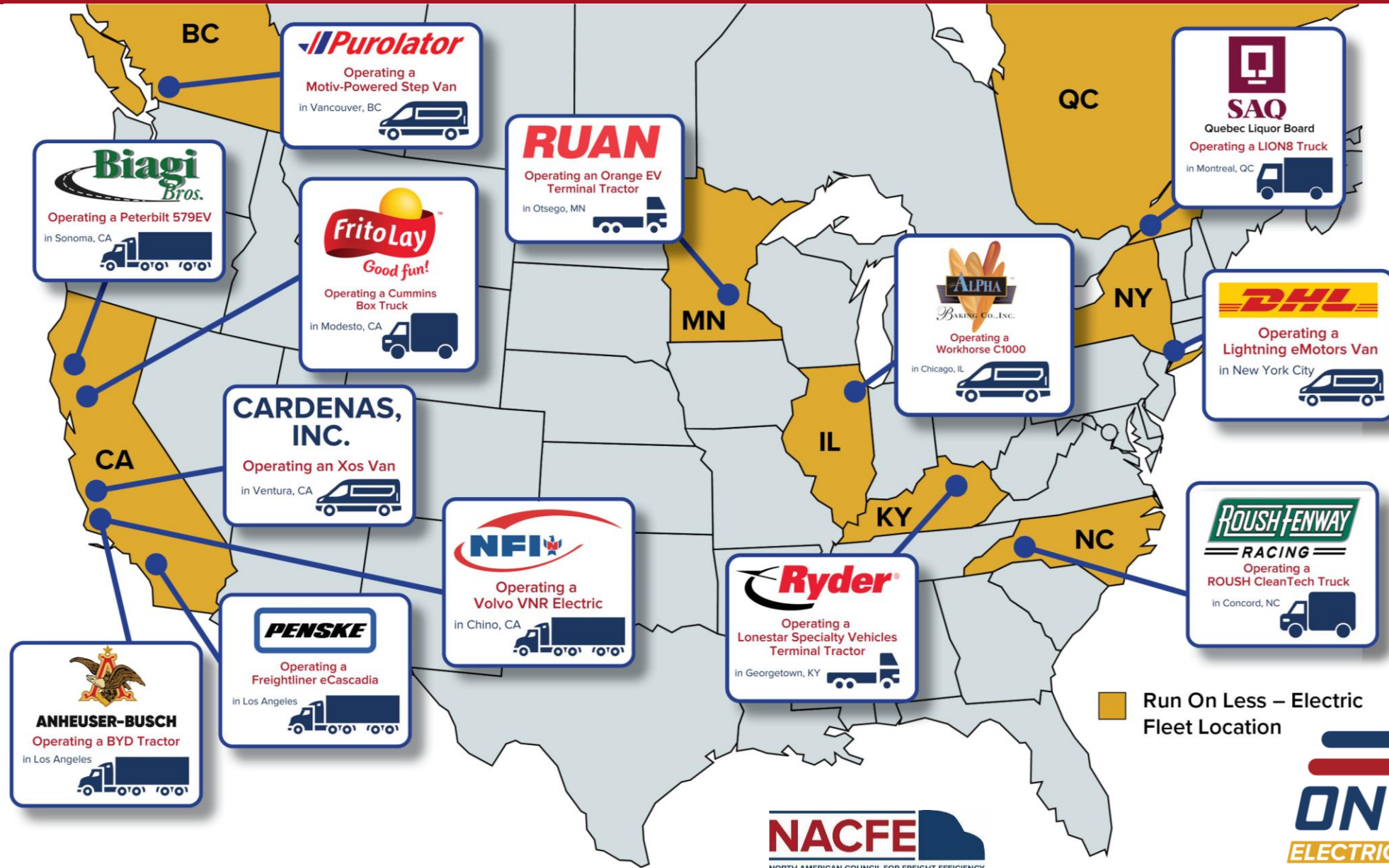
IN  
PARTNERSHIP  
WITH



with  
title  
sponsors



# Run on Less – Electric Participants



# Fleet Electrification Waves

Electrification waves drive  
RoL-E scope

1. Forklifts
2. ***Yard Tractors***
3. ***MD Urban Delivery***
4. ***Drayage***
5. ***Regional Haul Tractors***
6. Long Haul Tractors



# MD & HD Industry Segments

Market  
Size

**MD Delivery** (Box trucks & step vans)

Total Population: **1,900,000**

Miles: **125/day 25K/year**



**Regional Haul** (Day cabs & some sleepers)

Total Population: **800,000**

Miles: **450/day 80K/year**



**Long Haul** (Sleeper Tractors)

Total Population: **1,200,000**

Miles: **600/day 100K/year**

**School Bus** (yellow or white)

Total Population: **480,000**

Miles: **??/day 12K/year**



**MD Work Trucks** (Dump, stake, service, waste...)

Total Population: **470,000**

Miles: **125/day 25K/year**



**Vocational Class 8**  
(Construction, waste, dump...)

Total Population: **800,000**

Miles: **300/day 65K/year**



**Transit Bus** (public transportation)

Total Population: **150,000**

Miles: **??/day 35K/year**



**Yard Tractors** (holers, shuttles...)

Total Population: **35,000**

Miles: **10-20/day @ 10 MPH**



**Expeditors Class 5-8**  
(MD & HD rush deliveries...)

Total Population: **25,000**

Miles: **tbd/day 25K/year**

This slide is under development

Electrification Time Frame

# Pathways to HD Truck Charging



**1) Fleet Depot Based**



**2) Opportunity Charging  
Stores, Ports, Warehouses...**



**3) Shared Card Lock Locations**



**4) Truck Stops**



**5) Toll Road Rest Areas**



**6) Interstate Rest Areas**

**7) Mobile Roadside Charging (emergencies & service calls)**

**8) In Motion Charging**

# Electric Truck Bootcamp

- |         |   |
|---------|---|
| 4/20/21 | 1. Why Electric Trucks?                         |
| 5/4/21  | 2. Charging 101 - Planning & Buildout           |
| 5/18/21 | 3. Charging 201 - Power Management & Resilience |
| 6/1/21  | 4. Working with Your Utility                    |
| 6/15/21 | 5. Incentives for Electrification               |
| 6/29/21 | 6. Maintenance, Training & Safety               |
| 7/13/21 | 7. Finance & Innovative Business Models         |
| 7/27/21 | 8. Battery Supply Chains & End of Life          |
| 8/10/21 | 9. Global Perspectives                          |
| 8/24/21 | 10. Drivers & Electric Trucks                   |

**Register at:**

<https://subscribe.act-news.com/NACFE-RoL-e-2021>

**All sessions:**

- Start at 1 PM EDT
- Can be viewed later



# Guidance on Electric Trucks

# 1

**Electric Trucks: Where They Make Sense**

May 2018



**MD Electric Trucks: Cost Of Ownership**

October 2018

# 2

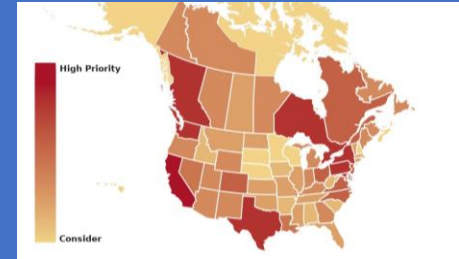
**Viable Class 7 & 8 Electric, Hybrid & Alt Fuels Tractors**



# 4

December 2019

**High Potential Regions**



# 5

November 2020

**Heavy-Duty Hydrogen Fuel Cell Tractors**



# 6

December 2020

# 3

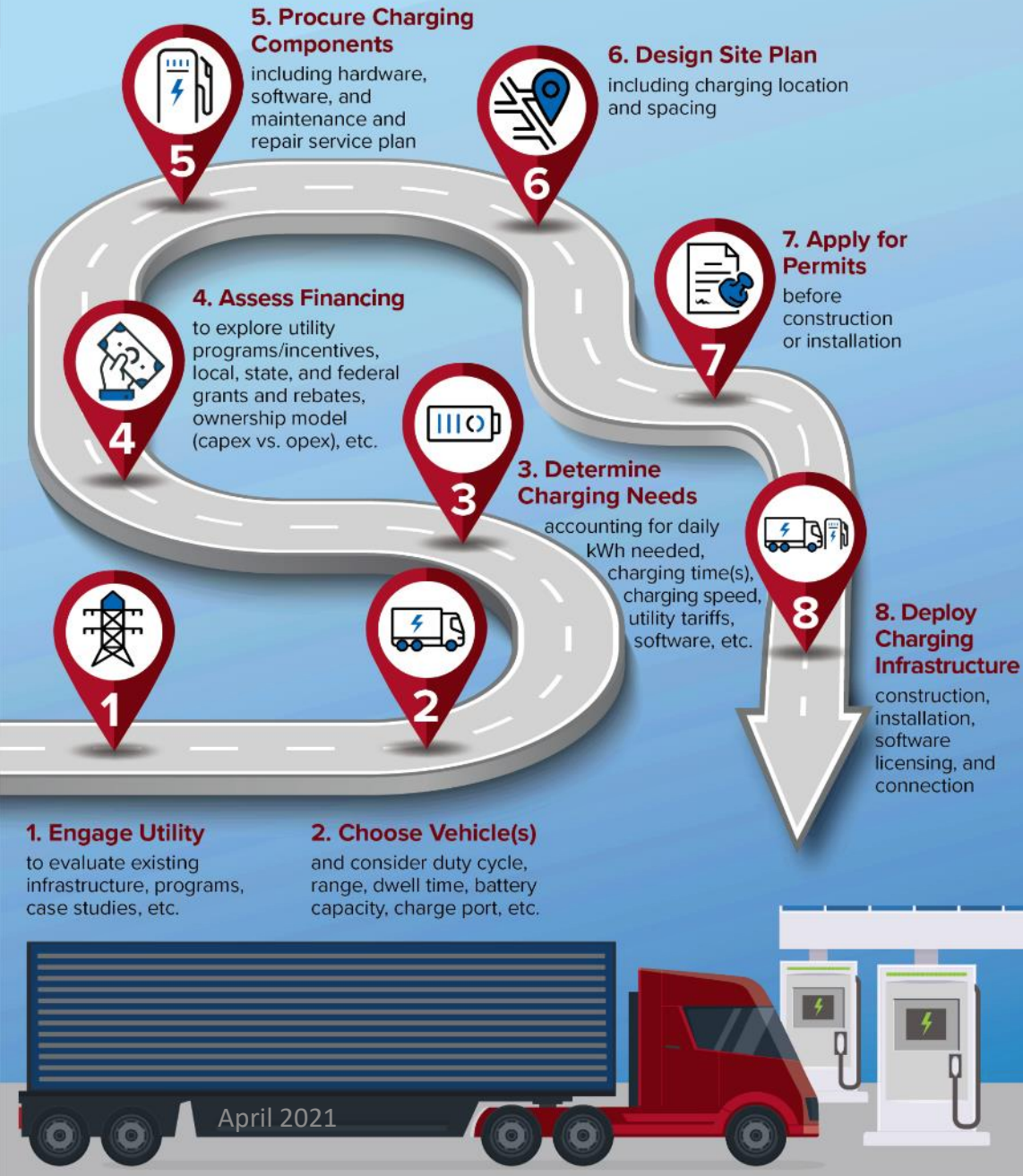
**Electric Trucks: Charging Infrastructure**

March 2019



Now Free Online at <https://nacfe.org/emerging-technology/electric-trucks-2/>

## Charging Procurement Roadmap



# Infrastructure

- Complex
- Large amount of power fast
- Involve all stakeholders early
- Time to complete with truck availability
- Be flexible

# HD Tractors Green Future

## **PRESENT: 2020**

Technology immature  
Many unknowns  
& challenges



## **“MESSY MIDDLE”: 2030**

Many optimized solutions  
Growing infrastructure  
Multi fuel choices

Innovation & maturation  
Facts replace estimates  
Learning curves

## **FUTURE: 2040**

Fast charging everywhere  
Long life, low cost batteries  
Acceptable weights



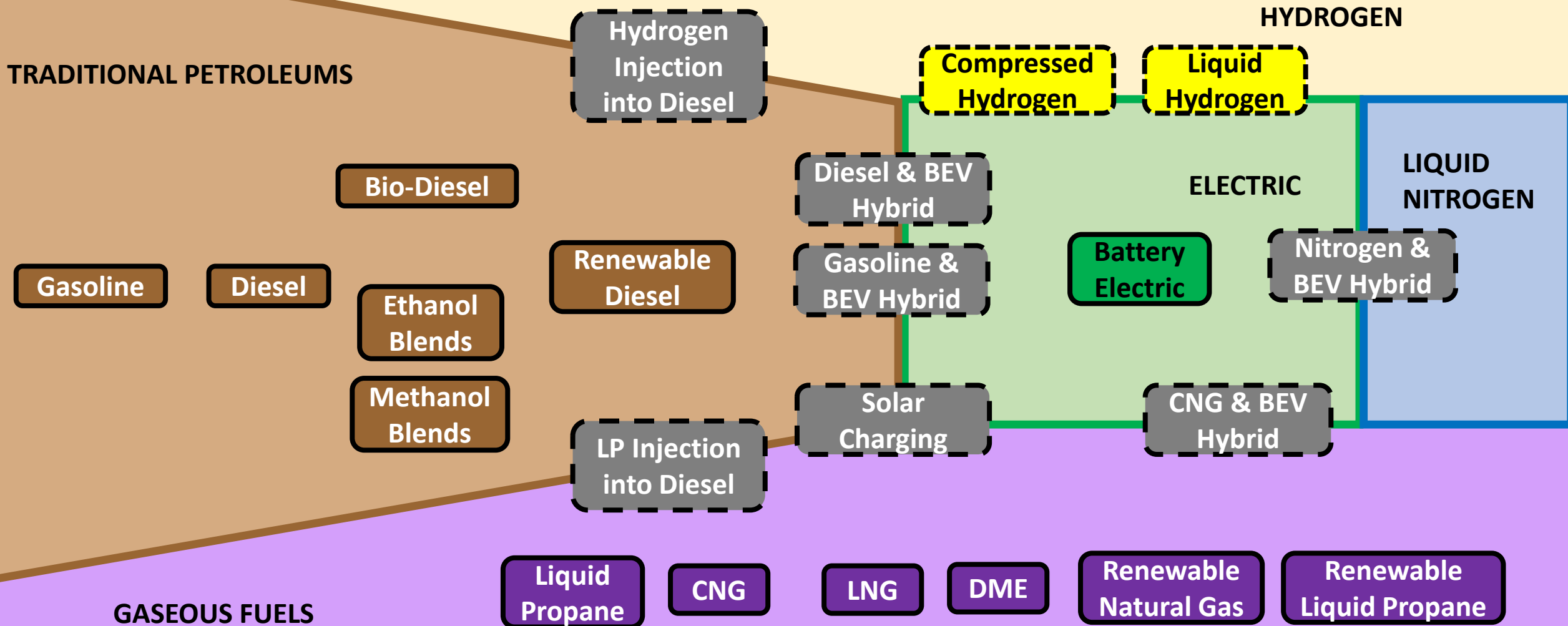
Legacy Diesels  
Natural Gas

Diesel Advancements  
Natural Gas  
Hybrids

Battery Electric  
Hydrogen Fuel Cells  
Renewable Natural Gas & Diesel

CBEV from  
Clean Energy

# Alternative Fuels



# Electric/Hybrid Trucks Catalog

The screenshot shows the 'ZERO-EMISSION TECHNOLOGY INVENTORY' website. At the top is a navigation bar with links: HOME, ABOUT, NEWS, EVENTS, RESOURCES, CALSTART, and CONTACT. Below the navigation bar is a header section with the title 'ZERO-EMISSION TECHNOLOGY INVENTORY' and a sub-header 'SELECT A VEHICLE PLATFORM TO EXPLORE'. Under this sub-header are ten circular icons representing different vehicle types: Transit Bus, School Bus, Shuttle Bus, Cargo Van, Yard Tractor, MD Truck, MD Step Van, HD Truck, and Other. Below the vehicle platform selection is another section titled 'SELECT A REGION' with a map of North America and 'SELECT A VEHICLE MANUFACTURER' with a grid of 60+ manufacturer logos including Alstom, BYD, Ford, GM, and many others. At the bottom left is a timeline titled 'REPORTED VEHICLE AVAILABILITY THROUGH 2023' with markers for 'Available', 2020, 2021, 2022, and 2023. A 'RESET FILTERS' button is located at the bottom left of the interface.

- “ZETI”
- Calstart on-line tool
- Part of ***Drive to Zero*** program at Calstart
- Launched March 2020
- Current & future production models
- Links to OEM web pages

<https://globaldrivetozero.org/resources/zero-emission-technology-inventory/>

# Some CBEVs will be “Range Extended”



Several OEMs and suppliers are working on hydrogen fuel cell powered electric trucks



Hyllion “Hypertruck” is being called ERX: Electric Range Extender and runs on CNG or RNG



## CNG Infrastructure

From DOE Alt Fuels Data Center

# Hydrogen & Battery Electric Trucks

Both Competitors *AND* Teammates

Hydrogen Fuel Cell Trucks	Truck Subsystem	Battery Electric Trucks
Yes (but less)	Rechargeable Batteries	Yes
Yes	Electric Drive Motors	Yes
Yes	High Power Cables	Yes
Yes	Software Management	Yes
Yes	Regenerative Braking	Yes
Yes	Hydrogen Fuel Cell	--
Yes	Hydrogen Fuel Tank	--
Hydrogen Station	Refueling	Electric Charging Station
Large	Electricity Consumption	Large

# Guidance on Hydrogen

## Hydrogen Color Spectrum

### GREEN

Hydrogen produced by electrolysis of water, using electricity from renewable sources like hydropower, wind, and solar. Zero carbon emissions are produced.

### TURQUOISE

Hydrogen produced by the thermal splitting of methane (methane pyrolysis). Instead of  $\text{CO}_2$ , solid carbon is produced.

### PINK/PURPLE/RED

Hydrogen produced by electrolysis using nuclear power.

### BLACK/GRAY

Hydrogen extracted from natural gas using steam-methane reforming.

### YELLOW

Hydrogen produced by electrolysis using grid electricity.

### BLUE

Grey or brown hydrogen with its  $\text{CO}_2$  sequestered or repurposed.

### WHITE

Hydrogen produced as a byproduct of industrial processes.

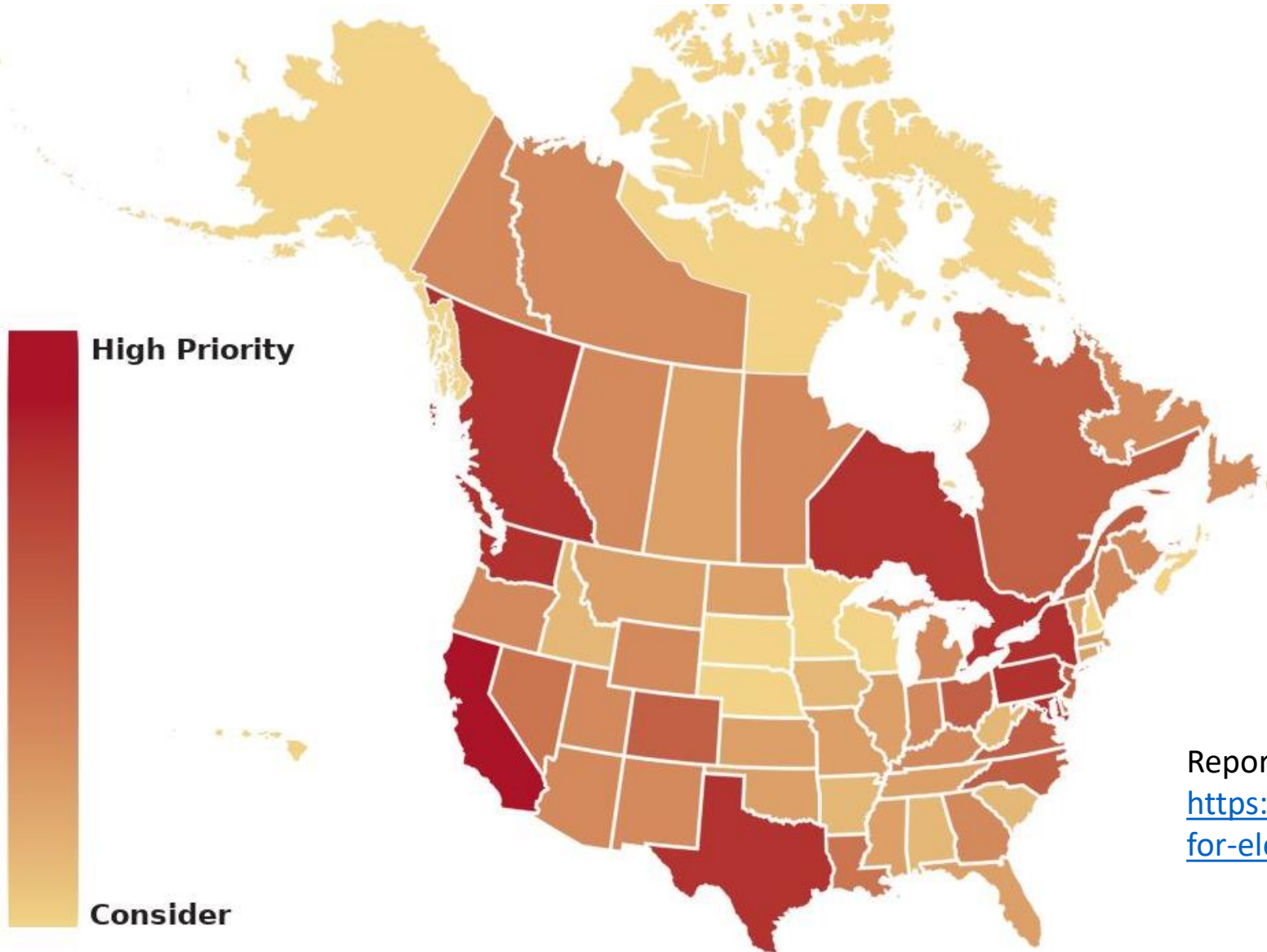
### BROWN

Hydrogen extracted from fossil fuels, usually coal, using gasification.



**Note:** There are no official definitions of these colors, but the above represents common industry nomenclature.

# High Potential Regions Report



Megaregions with particularly high potential

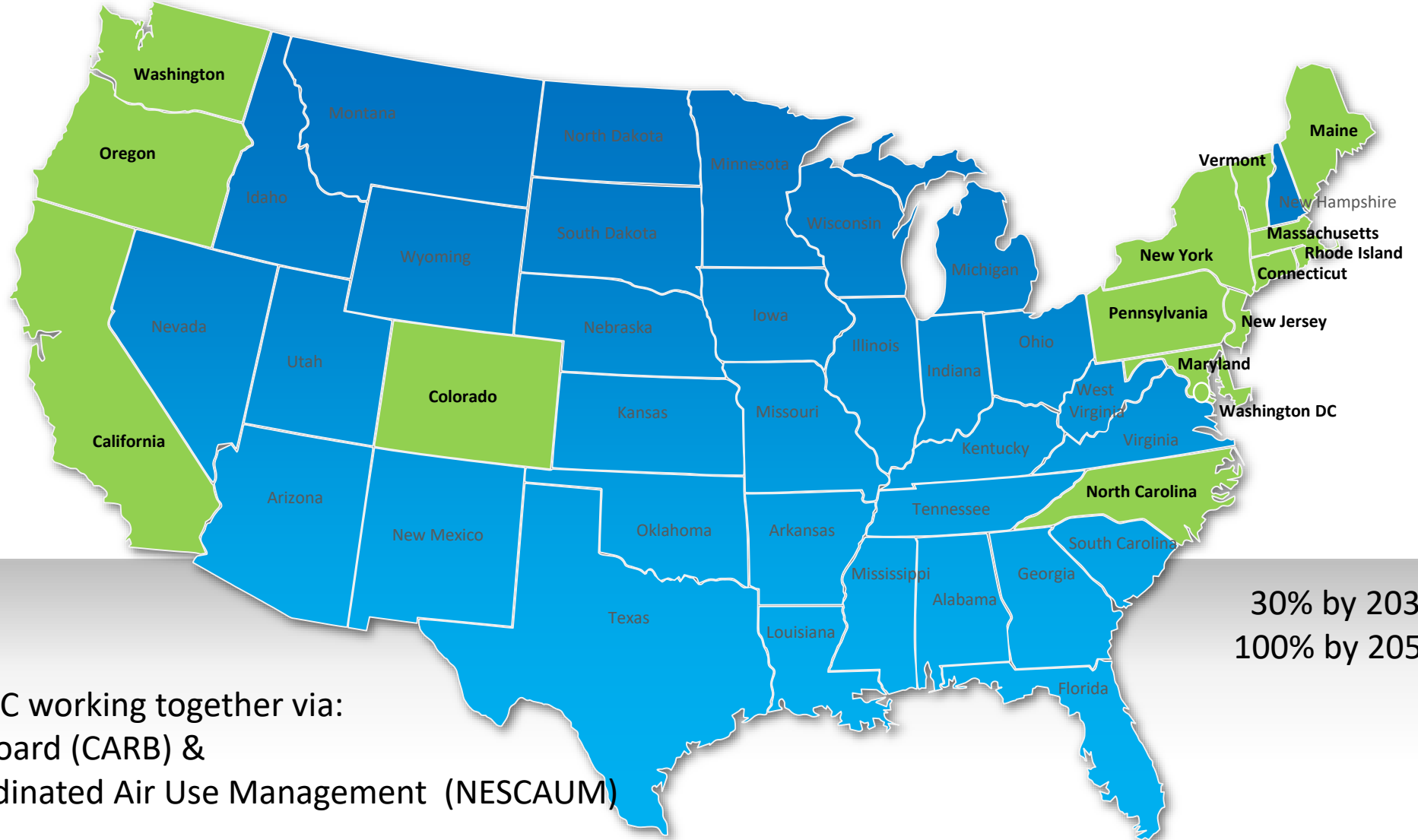
- Northern California
- Southern California
- Texas Triangle
- Cascadia (WA, OR & BC)
- Front Range (CO & NM)
- Northeast
- Toronto & Montreal

Report Link:

<https://nacfe.org/downloads/high-potential-regions-for-electric-truck-deployments-technical-appendix/>

April 2021

# Transition to Zero-Emission Trucks (& Buses)



30% by 2030  
100% by 2050

15 States & Washington DC working together via:  
California Air Resources Board (CARB) &  
Northeast States for Coordinated Air Use Management (NESCAUM)

April 2021

Memorandum Of Understanding signed July 14<sup>th</sup>, 2020

# Why Consider Electrification Now?

2021

JANUARY

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

FEBRUARY

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

MARCH

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

APRIL

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

MAY

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

JUNE

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

JULY

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

AUGUST

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

SEPTEMBER

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

OCTOBER

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

NOVEMBER

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

DECEMBER

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

## Financial

- Incentives are/will be available that can cover some of the costs of conversion

## Facilities

- Obtain required power levels BEFORE your neighbors
- Obtaining power/infrastructure can take years
- Might be easier to relocate than upgrade
- Physical layout of your lot will change

## Change is Coming: Even with diesel

- Regulations & tech changes for NOx & GHG



# Electric Trucks

## Collaboration

- Fleets
- OEMs (Existing *& New*)
- Suppliers
- Dealerships (Sales/Service)
- Governments
- *Charging System Suppliers*
- *Utility Companies*



# 10 Trends of Regional Haul Growth



April 2021

# Regional Haul

## More Regional Haul: An Opportunity for Trucking?

- Drop in Length of Haul
- Warehousing
- Technology Trends
- An Opportunity
  - Drivers
  - Alternative Fuels
  - Others?

Report published April 2019.

<https://nacfe.org/regional-haul/>

# Run on Less Regional



Results Fleets Technologies Videos News & Events ▾ About ▾

## Day 18 of 18

Congratulations to Our  
Drivers!

OCTOBER 7 – 25 2019

Run on Less Regional Sets Impressive  
Efficiency Benchmark



### RESULTS

[See the results](#)

## 8.3

Average MPG

## \$8,249

Dollars saved

## \$9,003,550,961

Annualized Potential Savings

Potential savings represents the savings that are possible across the industry if all regional-haul trucks operated at this level.

April 2021



Results Fleets Technologies Videos News & Events ▾ About ▾

All Results

RESULTS BY FLEET

C&S Wholesale Grocers

Hirschbach

Hogan Transportation

J.B. Hunt

Meijer

PepsiCo

Ploger Transportation

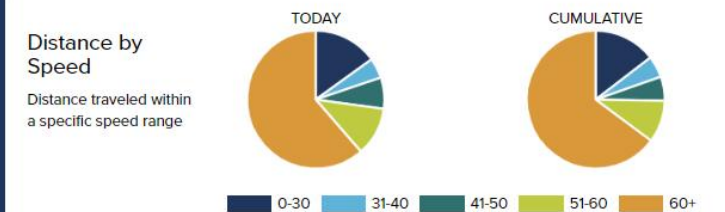
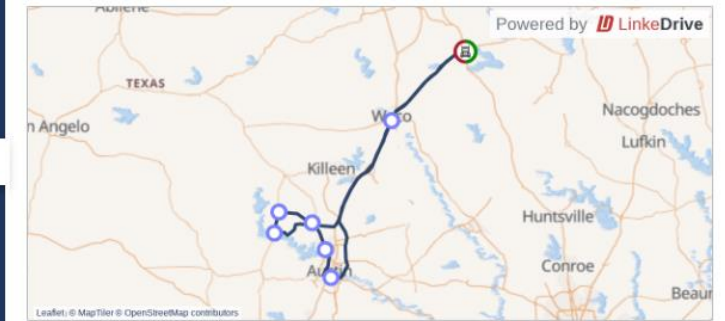
Schneider

Southeastern Freight Lines

United Parcel Service

OCTOBER 16, 2019: DAY 10 OF 18

Day  
10



# Run on Less Regional Reports

## Conclusions

1. High efficiency requires commitment
2. Optimize performance using big data and connectivity
3. Understand and act on the variety in duty cycles
4. Drivers are attracted to regional haul
5. Return to base is ideal for electric trucks
6. Growth in Regional Haul is Good

## Run On Less Data Benefits

- Run on Less Regional data analysis: [RoLR final report](#)
- NREL/NACFE Report: [Battery Electric Powertrains](#)
- Ballard/NACFE Report: [Hydrogen Fuel Cell Trucks in Regional Haul](#)
- Free [downloadable data set](#)



# Getting to Know Each Other



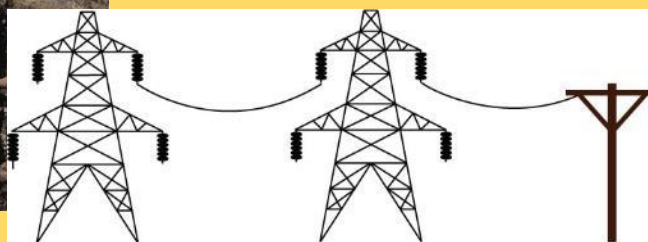
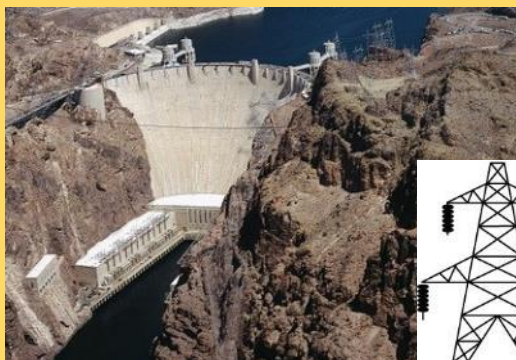
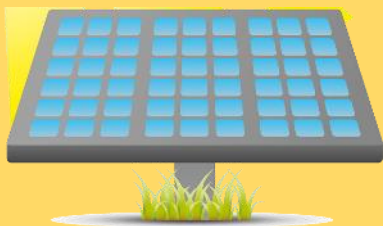
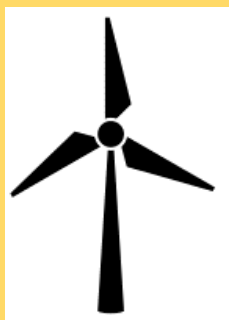
## FLEETS



Primer:  
FLEETS  
on  
UTILITIES



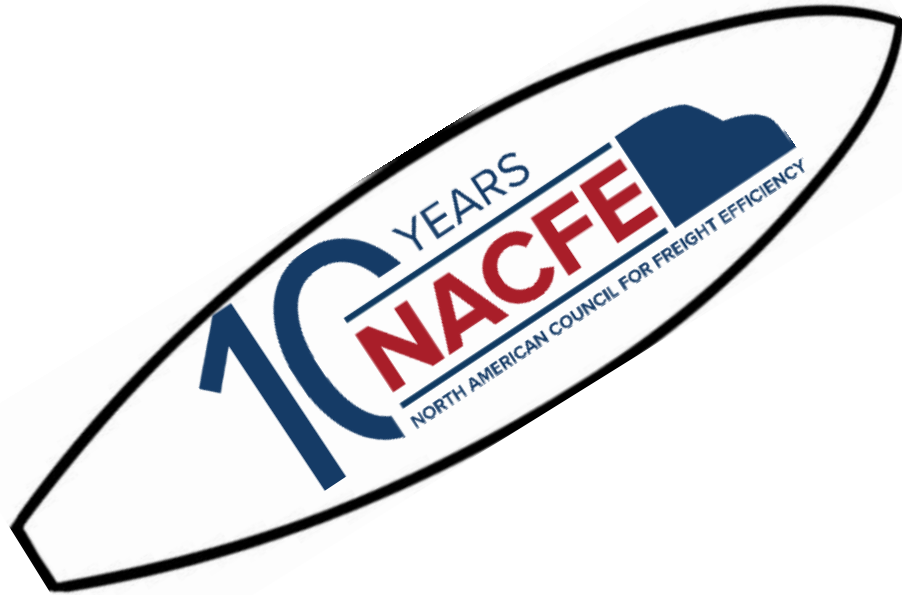
Primer:  
UTILITIES  
on  
FLEETS



## UTILITIES

April 2021

# Wave Of Changes Coming



A collection of industry trends and challenges arranged in a curved path, including:

- Covid-19
- Autonomous Vehicles
- Driver Retirement
- Electrification
- IMO 2020
- Hours Of Service
- 2 Truck Platooning
- GreenHouse Gas Phase 2
- Alternative Fuels
- Solar
- Parking Shortage
- Lightweighting
- Cameras
- BIG DATA
- Driver Retention
- Artificial Intelligence
- blockchain
- Aerodynamics

Mike Roeth, 260.750.0106, [mike.roeth@nacfe.org](mailto:mike.roeth@nacfe.org)

Dave Schaller, 260.602.5713, [david.schaller@nacfe.org](mailto:david.schaller@nacfe.org)

Follow NACFE at:



[www.NACFE.org](http://www.NACFE.org)

[www.RunonLess.com](http://www.RunonLess.com)